

XXXV.—*The Osteology and Classification of the Teleostean Fishes of the Order Microcyprini.* By C. TATE REGAN, M.A.

(Published by permission of the Trustees of the British Museum.)

[Plate VIII.]

As defined and limited in the 'Cambridge Natural History' the group Haplomi includes a number of families of soft-rayed fishes with abdominal pelvic fins, which are thrown together because they lack the mesocoracoid bone, the presence of which characterizes the order Isospondyli or Malacopterygii. It was only to be expected that further study of such a large and heterogeneous group, defined by a single negative character, would prove it to be unnatural.

I have already called attention to the fact that *Retropinna*, *Microstoma*, and *Salanx* have no mesocoracoid*, although they are closely related to the Argentinidæ, in which that bone is well developed. Moreover, *Retropinna*, which represents *Osmerus* in Australia and New Zealand, is a connecting-link between the northern family Argentinidæ and the southern Haplochitonidæ and Galaxiidæ. All these fishes are extremely similar in osteology, dentition, and other characters, and are very closely related. The Haplochitonidæ and Galaxiidæ, then, are not Haplomi, although they have lost the mesocoracoid; they are Salmonoids.

The third family of the Haplomi in the 'Cambridge Natural History' is the Enchodontidæ, Cretaceous fishes which seem to me to be related to the Stomiatidæ, which they resemble in mouth-structure and in cranial osteology.

I have already dealt with the osteology and classification of many of the other groups included in the Haplomi by Boulenger, viz. the Percopsidæ (which I have united with the Aphredoderidæ to form the isolated order Salmopercæ), the Stephanoberycidæ (provisionally placed with the Melamphaidæ in an order Xenoberyces, apparently related to the Berycomorphi), the Scopelidæ, Alepidosauridæ, Cetomimidæ, and Chirothricidæ, which with the Ateleopidæ form the order Iniomi, an offshoot from very primitive isospondylous fishes.

The Kneriidæ have already been removed to the Isospondyli by Boulenger (Cat. African Freshwater Fish.); this family is not very remote from the Chanidæ.

* Ann. & Mag. Nat. Hist. (8) iii. 1909, p. 82.

There remain, then, for consideration only the Esocidæ, Umbridæ, and Dalliidæ, the Haplomi *sensu strictu*, and the Cyprinodontidæ and Amblyopsidæ, for which I have proposed the ordinal name Microcyprini.

These two groups resemble each other in the absence of a mesocoracoid and an orbitosphenoid, the separation of the parietals by the supraoccipital, &c., but they differ widely in other respects, and do not seem to be closely related.

The Haplomi are physostomous, the maxillary enters the gape, the mesethmoid is represented by a pair of dermal bones, and the ribs are borne on autogenous parapophyses*. The Microcyprini appear to be physoclistic, the mouth is bordered above by the præmaxillaries only, the mesethmoid is unpaired, and all or most of the ribs are inserted on strong transverse processes. Whereas the Haplomi show relationship to the most generalized isospondylous fishes, the Microcyprini bear more resemblance to the Salmopercæ and Synentognathi, especially the latter.

Order MICROCYPRINI.

Malacopterous physoclists with abdominal pelvic fins, each of 6 or fewer rays. No lateral line. Mouth terminal, bordered above by the præmaxillaries; second, third, and fourth upper pharyngeals dentigerous; lower pharyngeals either separate, or if united with the median suture persistent; branchiostegals 6 or less. Parietals separated by supraoccipital; mesethmoid unpaired; no orbitosphenoid; alisphenoids well separated; basisphenoid, when present, small, free superiorly; roof of myodome membranous or thinly ossified; a short occipital, but no parietal crests. Pectoral arch attached to skull; post-temporal forked, or the lower limb sometimes ligamentous; supra-cleithrum small; no mesocoracoid; radials 4, short and broad, 2 or 3 on hypercoracoid. Vertebral column of solid centra which are co-ossified with the arches; all or most of the præcaudals with strong parapophyses bearing the ribs; epipleurals, but no epineurals; ribs commencing on second vertebra; no upturned centra at base of caudal fin; hypurals ankylosed with the last centrum.

I have examined a number of genera, and I believe that all are physoclistic, but I have not undertaken the detailed research necessary to establish this. Valenciennes came to

* Cf. Starks, Biol. Bull. vii. 1904, p. 254, and Zool. Jahrb. 1904, p. 249.

the same conclusion in the case of *Pæcilia* and *Anableps* (Hist. Nat. Poiss. xviii. 1846, pp. 126, 258), and Philippi has recently shown that *Glaridichthys* and *Unesterodon* are physoclists (Sitzungsber. Gesellsch. naturf. Freund. 1906, p. 232).

Starks has published some notes on the osteology of *Amblyopsis*, *Cyprinodon*, *Fundulus*, and *Pæcilia* (Biol. Bull. vii. 1904).

Suborder 1. AMBLYOPSOIDEA.

Mouth rather wide, not protractile; teeth in jaws and on palatines; gill-membranes attached to isthmus; pelvic fins small or absent; vent jugular. Parietals large; opisthotic normal. Palatine distinct from pterygoid; metapterygoid present. No post-cleithrum. Præcaudal vertebræ with parapophyses from the fourth; first two ribs sessile.

Family Amblyopsidæ.

This family includes *Chologaster* and the blind cave-fishes *Amblyopsis* and *Typhlichthys* (cf. Jord. & Everm. Bull. U.S. Nat. Mus. xlvii. 1896, p. 702). I am able to confirm Stark's account of the skeleton of *Amblyopsis* (Biol. Bull. vii. 1904, p. 261), except for the statement that all the præcaudal vertebræ have parapophyses. Eigenmann has studied the degeneration of the eyes in the blind cave-fishes ('Cave Vertebrates of America': Washington, 1909).

Suborder 2. PÆCILIOIDEA.

Mouth small, unless the jaws are produced; præmaxillaries usually protractile; maxillary little movable, adnate to præ-orbital; teeth in jaws and sometimes on vomer, never on palatines; gill-membranes free from isthmus; pelvic fins usually well-developed, 6-rayed, sometimes absent. Parietals, when present, small or moderate; opisthotic, if present, adherent to outer surface of exoccipital. Palatine and pterygoid ankylosed; no metapterygoid. A single laminar post-cleithrum on each side (except in *Anableps*). Præcaudal vertebræ with parapophyses from the first or second; all the ribs on parapophyses.

The fishes of this suborder have usually been regarded as a single family, *Cyprinodontidæ* or *Pæciliidæ*; in that case several subfamilies should be recognized.

Family Pœciliidæ.

Synopsis of the Subfamilies.

- I. Exoccipital condyles present; anal fin of both sexes similar in position.
- A. Oviparous; anal fin of both sexes similar in structure*.
1. Teeth tricuspid; parietals absent 1. *Cyprinodontinæ*.
2. Teeth conical or villiform.
- Parietals present; pelvic fins present; epipleurals simple 2. *Fundulinæ*.
- Parietals absent; pelvic fins absent; epipleurals bifurcate or trifurcate 3. *Orestiinæ*.
- B. Viviparous; anal fin of male with the first 5 or 6 rays short, stiff and subequal, separated by a shallow notch from the rest of the fin 4. *Characodontinæ*.
- C. Viviparous; anal fin of male modified into an intromittent organ, the rays of the fin supporting the tubular prolongation of the urogenital duct.
- Eyes normal; intromittent organ naked; skull normal; vertebræ 31 5. *Jenynsiinæ*.
- Eyes divided transversely; intromittent organ scaly; skull very depressed; vertebræ 46 to 53. 6. *Anablepinæ*.
- II. Exoccipital condyles absent; viviparous; anal fin of male advanced and some of its anterior rays enlarged and produced.
7. *Pœciliinæ*.

1. *CYPRINODONTINÆ*.

Differ from the *Fundulinæ* only in the tricuspid teeth and the absence of parietals. Vertebræ 26 (in *Lebias dispar*).

Cyprinodon and *Jordanella* from North America; *Lebias* and *Tellia* from Africa and Southern Europe. Some of the species are marine. The Miocene *Pachylebias*, A. S. Woodward, may be placed here.

2. *FUNDULINÆ*.

Oviparous. Teeth conical or villiform. Parietals present. Exoccipital condyles well developed. Epipleurals simple.

The most generalized and the most widely distributed group of the Pœcilioids. None differs much from *Goodea* in osteology, but *Lamprichthys* retains the basisphenoid, as in the *Cyprinodontinæ*.

The vertebræ number 28 to 41 (28 in *Haplochilichthys*,

* Except in some species of *Fundulus* in which the oviduct is produced on the anal fin.

29 in *Panchax*, 32 or 33 in *Fundulus*, 34 in *Rivulus*, 41 in *Lamprichthys*).

The South-American genera of this subfamily are *Rivulus* and *Cynolebias*. The North-American species are numerous; many are marine, and most of them appear to be congeneric with *Fundulus heteroclitus*; *Lucania* and probably *Empetrichthys* are related genera. With the exception of the problematical *Fundulichthys virescens*, the Asiatic species fall into two groups; in both the short dorsal fin is placed above the posterior end of the rather long anal, but they differ widely in other respects. In the one the præmaxillaries are flattish and somewhat produced, protractile, the cleft of the mouth is rather wide, horizontal, almost semicircular, the teeth are in bands, with an outer and a more or less distinct inner series of enlarged teeth, vomerine teeth and pseudo-branchiæ are present, the gill-membranes are not united, and the pectoral fins are placed low. In the other the mouth is small, transverse, not protractile, with the teeth in a single series, sometimes followed by a second series of minute teeth; there are no vomerine teeth or pseudobranchiæ, the gill-membranes are broadly united, and the pectoral fins are placed high. McClelland, in 1839, included one species of each group in his genus *Aplocheilus* (*Haplochilus*). Valenciennes, in 1846, gave the name *Panchax* to the first of these groups, and Bleeker afterwards definitely restricted *Haplochilus* to the second. *Oryzias*, Jord. & Snyder, is a synonym of *Haplochilus*.

Most of the African fishes which have been referred to *Haplochilus* belong to one or the other of two rather distinct types; a number of species may be placed in *Panchax*, since they differ from the Asiatic species of that genus only in the less produced præmaxillaries; *H. playfairii*, *sexfasciatus*, *fasciatus*, *senegalensis*, *choperi*, &c. are species of *Panchax*. Several species which have been placed in *Haplochilus* appear to be congeneric with *Haplochilichthys spilauchen*; in these pseudo-branchiæ and vomerine teeth are always absent, but they are not invariably present in *Panchax*. *Haplochilichthys* resembles *Haplochilus* and differs from *Panchax* in the high position of the pectoral fins and the united gill-membranes, but has the mouth protractile and the teeth in bands, the outer series enlarged; *H. macrurus*, *johnstonii*, *antinorii*, *myoposæ*, &c. are species of this genus. *Procatopus* is closely related to *Haplochilichthys*. Most of the African species which have been placed in *Fundulus* appear to belong to the genus *Nothobranchius*, which differs from *Panchax* in having the dorsal fin as long as the anal.

I here propose the new generic name *Lamprichthys* for *Haplochilus tanganicanus*, Bouleng., a silvery fish which differs from *Haplochilichthys* in the strongly compressed body, the very long anal fin, and the more numerous vertebrae (41 instead of 28).

The Oligocene and Miocene *Prolebias*, Sauv., seems to be related to *Fundulus*; it has 32 to 34 vertebrae (A. S. Woodward, Cat. Foss. Fish. iv. p. 290, 1901).

3. ORESTIINÆ.

The remarkable genus *Orestias* includes about twelve species from elevated lakes in the Andes of Peru, Bolivia, and Chile. Externally it differs from *Fundulus* chiefly in the absence of pelvic fins, but the absence of parietals and the forked epipleurals are differences of considerable importance. Vertebrae (in *O. pentlandii*) 36. Pellegrin has given an interesting account of these fishes ('Lacs des Haut Plateaux de l'Amérique du Sud,' 1907; also in C. R. Acad. des Sciences, 1904, and Bull. Soc. Zool. xxix. 1904, p. 90).

4. CHARACODONTINÆ.

Differ from the Fundulinæ especially in that they are viviparous: the anal fin of the male has the first 5 or 6 rays short, stiff and subequal, separated by a more or less distinct notch from the rest of the fin. Vertebrae rather numerous (38 in *Zoogoneticus robustus*, 44 in *Goodea atripinnis*). Four genera, *Zoogoneticus*, *Goodea*, *Girardinichthys*, *Characodon*, with seventeen species, almost peculiar to the system of the Rio Lerma in Mexico.

Zoogoneticus has the jaws and teeth of a *Fundulus*, but *Characodon* and *Girardinichthys* connect it with *Goodea*, in which the mouth is small, the teeth are movable, compressed, and bicupid, and the rami of the lower jaw are loosely connected (cf. Regan, Biologia Centr.-Am., Pisces, pp. xviii and 85).

5. JENYNSINÆ.

Jenynsia, with three or four species from the La Plata and Argentina, has the osteological characters of the Fundulinæ, but it has tricuspid teeth and is viviparous; the male intromittent organ is so similar to that of *Anableps* that it can hardly have been independently evolved in the two genera. As noted by Garman, the males of *Jenynsia* are "rights and lefts," i. e. the intromittent organ is more easily

moved to one side than the other, is usually somewhat curved towards that side, and is otherwise not quite symmetrical; the urogenital orifice of the female appears to be median and symmetrical.

6. *ANABLEPINÆ.*

The remarkable genus *Anableps*, with three species from Central and South America, shows relationship to *Jenynsia* in the structure of the intromittent organ, but has a number of other characters which are unique in the suborder. The eyes are divided transversely into an upper and a lower portion, the former raised above the surface of the head and adapted for vision in the air. The skull is flat, so depressed that in the orbital region the broad parasphenoid and the frontals are separated by a scarcely perceptible interspace; the frontals are raised above the orbits; there are no post-cleithra and the pelvic bones are well separated; the vertebræ are numerous (46 to 53), the præcaudals with strong parapophyses which are grooved superiorly and have the ribs attached near their distal extremities.

Garman's account of this genus ('The Cyprinodonts,' pp. 70-79, pls. vi. & vii.) is of considerable interest; he has shown that both males and females are "rights and lefts;" in *Anableps anableps* the female urogenital orifice is covered by an enlarged scale, unattached on one side or the other, so as to open to the right or left; presumably dextral males pair with sinistral females, and *vice versa*.

7. *PÆCILINÆ.*

The fishes of this subfamily differ from all the others of the order in the absence of exoccipital condyles. They are viviparous, and in the males the anal fin is advanced and modified, some of the anterior rays being enlarged and produced. Eigenmann has studied the structure of this intromittent organ in the Pæciliids of the La Plata (Proc. U.S. Nat. Mus. xxxii. 1907, p. 425); he has found that it is the third, fourth, and fifth rays which are prolonged; these rays may be rolled up to form a tube, or they may be armed with recurved hooks or with terminal finger-like or antler-like processes. The anal fin of the male is supported by special bony stays, 2 to 5 in number, which project downwards and forwards from the bridges connecting the parapophyses of some of the posterior præcaudal vertebræ (*cf.* Garman, 'The Cyprinodonts,' pl. viii.).

The osteology is much as in the Fundulinæ, except for

the characters noted above; parietals are present, but there is no basisphenoid. Vertebrae 30 to 36 (*Gambusia* 32, *Belonesox* 36, *Pæcilia*, *Mollienisia*, and *Xiphophorus* 30 or 31).

The principal genera are *Belonesox*, *Gambusia*, *Petalosoma*, *Glaridichthys*, *Cnesterodon*, *Heterandria*, *Pæcilia*, *Girardinus*, *Acanthophaeus*, *Phalloptychus*, *Phalloceros*.

In *Belonesox* the jaws are produced and the teeth cardiform; some of the others are carnivorous and have the mouth and dentition of a *Fundulus*, but these are closely related to those mud-eating forms which have a small transverse mouth, movable compressed teeth, and the rami of the lower jaw loosely connected. All the species are American, ranging on the coasts and in the rivers from the southern United States to the La Plata, and especially abounding in Central America and the West Indies. The males of some of the species are among the smallest known fishes.

EXPLANATION OF PLATE VIII.

Goodea atripinnis.

Fig. 1. Hyopalatine and opercular bones (internal view). *pal*, palatine; *q*, quadrate; *ms*, mesopterygoid; *hm*, hyomandibular; *sy*, symplectic; *op*, operculum; *sop*, suboperculum; *iop*, interoperculum.

Fig. 2. Pectoral arch (except post-temporal and supra-cleithrum). *cl*, cleithrum; *pcl*, post-cleithrum; *sc*, hypercoracoid; *cor*, hypocoracoid; *r*, radials.

Figs. 3-5. Skull: 3, from behind; 4, from above; 5, from below. *soc*, supraoccipital; *boc*, basioccipital; *eoc*, exoccipital; *epo*, epiotic; *opo*, opisthotic; *spo*, sphenotic; *pto*, pterotic; *pro*, pro-otic; *asp*, alisphenoid; *psp*, parasphenoid; *v*, vomer; *eth*, mesethmoid; *leth*, lateral ethmoid; *n*, nasal; *por*, præorbital; *f*, frontal; *p*, parietal; *ptt*, post-temporal.

XXXVI.—The Classification of the Teleostean Fishes of the Order Syngnathi. By C. TATE REGAN, M.A.

(Published by permission of the Trustees of the British Museum.)

[Plate IX.]

THE order Syngnathi (Pharyngognathi malacopterygii of Johannes Müller) may be shortly diagnosed as comprising malacopterous physoclists with the lower pharyngeals completely united. In these fishes the dorsal fin is placed far back, above the anal, the branched rays of the caudal are only 13 in number, the pectorals are placed high, and the